Statement of Work

Design and Modification of Test Fixture for Tests

C.1 Background

The rail industry is interested in using liquefied natural gas (LNG) as an alternative fuel to power locomotives. The rail industry is considering the use of modified and enhanced design DOT 113 tank cars as LNG fuel tenders. In addition, a number of shippers are interested in shipping LNG, as a commodity, by rail to service a variety of customers. LNG is allowed to be shipped by rail in UN Portable T75 tanks (also called ISO tanks), subject to the approval of the Associate Administrator for Safety, Federal Railroad Administration (FRA). Currently, LNG is not authorized for shipments by rail in cryogenic tank cars (DOT 113 specification). The use of LNG as a locomotive fuel is currently being tested in pilot projects at two railroads. Also, another large railroad has recently submitted application to FRA to initiate a pilot project using a legacy tender (tank) car to evaluate the use of LNG as a locomotive fuel. Furthermore, the Association of American Railroads (AAR) has constituted a Committee [Natural Gas Fuel Tender (NGFT) Technical Advisory Group (TAG)], in which FRA is an active participating member. This Committee is charged with developing standards for the design and safe operation of LNG tenders for locomotives. The standard has not been finalized and is in final developmental stages. It is anticipated that, initially, the bulk of the standard's prescriptive requirements will address the design and use of a tank car type LNG tender. Several potential accident scenarios, involving the LNG tender, have been considered in the standard development. Analyses of the tender's structural performance under the postulated accident scenarios were modeled using finite element analysis by the AAR. In addition, the FRA contracted with DOT's Volpe Center to evaluate the tender performance under these postulated accident scenarios using simplified lumped-parameter analyses. These analyses evaluate the crashworthiness of the tender tank to contain the LNG, without any leak. However, no experimental data exist to evaluate the crashworthiness of the tank of a cryogenic, double tank design such as that used in an LNG tender.

There is also no test data on the survivability, in the collision scenarios, of various tender components such as valves, piping and pipe to shell weld joints necessary for design of the tender as a fuel supply vessel. Because of the locations of valves and piping, and their general less robust construction (compared to the tanks) they may present a higher probability of failure, leading to LNG or gaseous natural gas releases. While the design of the valve arrangement conforms to "fail safe - normally closed" condition when no gas is being fed to the locomotive or when an "anomaly" occurs in any of the systems, it is uncertain that the functionality of the valves can be ensured in an impact or collision where the valve and pipe assembly suffers physical damage. However, all valves are open when the tender is supplying gas to the locomotive; should an accident occur under this condition (or an impact situation), the impact or collision may affect the functionality of the valves (to close) by damaging those elements of a valve that are machined to close tolerances. The operation of moving parts of the valves cannot be assured if the valve stems are bent or the seating of the valve poppet on the

rim is misaligned leading to valves being stuck in open positions. Such a failure could lead to uncontrolled release of LNG (or the gas). Therefore, the survivability of the valve functions to cut off supply and shut off any LNG or gas flow needs to be investigated under the postulated accident conditions.

C.2 Objective

The purpose of the work described within this statement of work is to fabricate two LNG tender cabinets which protect the enclosed valves and fittings in the event of a collision with a tractor-trailer, to understand the structural performance of liquefied natural gas (LNG) tank cars used as fuel tenders and LNG commodity transport vessels. Also, provide technical support with the installation of one of the tender cabinets on a FRA tank car and for the impact test.

C.3 Scope

FRA in contract with Transportation Technology Center, Inc. (TTCI) will perform a dynamic impact test to determine structural performance of side cabinet assemblage with internal operational components, as described in the AAR Natural Gas Fuel Tender Specifications, M-1004. It will be impacted by an 80,000-pound load at 40 mph. In addition, FRA requires technical support and engineering services from the contractor in preparing the test articles and at the execution of the proposed test. To this end, the Contractor shall perform the following tasks, as a minimum.

C.4 Technical Approach and Phases

The work consists of two phases for the full completion of the project. In Phase I, the Contractor will fabricate two (2) side cabinet assemblies and assist TTCI in the installation of one (1) of the cabinets on the side of the tank car in preparation for the impact test. Verification of the Tank Car functionality, modification of the Tank Car for installation of the tender cabinet, if required. In Phase II, the Contractor will support and provide technical assistance on the execution of the impact test.
Phase I has a twelve (12) month period of performance. When Phase 1 is fully completed, FRA will provide authorization and funding to proceed with Phase II. The period of performance for Phase II is 12 months, for a total of 24 months for both Phases.

C.4.1 Phase I – Fabricate Side Cabinet Assemblage Test Fixture

Sub-task 1.: Fabrication of Side Cabinet Assemblage Test Fixture (Fixed Price)

This subtask is focused on the fabrication of a test fixture that will consist of the valves and piping used to control the transfer, shut off the flow or distributes LNG into or out of the tender and the flow of gaseous natural gas (GNG) to the locomotive. This design will mimic the actual design and configuration of flow control valves, piping and their locations in current or proposed LNG tender fuel cars. The Contractor will fabricate two test fixtures of the side cabinet assemblage of a LNG cryogenic tank car, consisting of the valves and pipes used to distribute LNG throughout the dual fuel locomotive system. In addition, the piping-valving

configuration shall be capable of sustaining flow of a liquid and gas streams (to simulate LNG flow to the heat exchanger and gas flow from the heat exchanger to the locomotive). Provisions shall also be made in the design to accommodate the use of liquid nitrogen or water-air system to simulate LNG and GNG flows. Commercially available components and materials should be used for the test fixture. This test fixture will be mounted on a tank car (not on the available DOT 113). Working with TTCI and the FRA, the Contractor will provide input into determining the mounting scheme of the test fixture, provide input in selection of the appropriate fluids to be used for the tests based on safety and cost considerations.

Sub-task 1.1: Installation of test fixture on a tank car

The Contractor will travel to the TTC and work with the FRA and TTCI to install the test fixture on the tank car at the Transportation Technology Center (TCC) in Pueblo, CO..

Sub-task 2.: Review existing state of test articles/cars and conduct preparation work (Time & Material)

The contractor shall conduct a detailed inspection of the FRA tank car and its components to determine the suitability for use in the testing program. If minor damage exists, the contractor shall detail the damage in a report with photographs and prepare an estimate for conducting appropriate repairs. After review and approval of the COR, the Contractor will proceed with the proposed repairs. If the tank car and its components are in good condition but for the specific test requires modification for introduction of new components, the contractor shall review the cut-drawings provided by the FRA and assess if any modifications should be made. Upon approval of the COR, the contractor shall proceed with the preparation work and document the process in a letter report. The report should include description of the existing status of the tank car and components, note repairs conducted and the manner of implementing the repairs and a description of the types of bracing used, if necessary, to keep the tank car and components in place. The contractor shall provide a cost summary that breaks down the labor into inspection, repair, design, and reporting categories as well as note any material costs for this task.

Government Furnished equipment. The Government will provide the following equipment:

- Test Tank car (to be determined)

Sub-Task 3 : Reporting (Fixed Price)

The contractor shall prepare a report detailing the work conducted under this statement of work. A draft final report shall be provided within 60 days after completion of the work. The contractor shall address issue raised by the COR in a timely manner and provide the final report within 30 days after receiving comments from the COR. Additionally, the contractor shall develop Research Results for each project completed.

C.4.1 Phase II – Support in the execution of tests, modification for the Tank Car in preparation for fire test.

Sub-Task 1: Support in the Execution of the Tests (Fixed Price)

The Contractor will provide support to the FRA and TTCI in the execution of the impact test. This will include, but is not limited to, input on the test setup, mounting of the test fixtures, instrumentation, data collection, post-tests inspection and evaluation of test fixture. The Contractor will be present during the tests setup and provide support as necessary during the execution of the test.

Sub-Task 2: Final Reporting (Fixed Price)

The contractor shall prepare a report detailing the work conducted under each phase of the project. A draft final report shall be provided 30 days after completion of the test. The contractor shall address issue raised by the COR in a timely manner and provide the final report within 30 days after receiving comments from the COR. Additionally, the contractor shall develop Research Results for each project completed.

C.5 - Deliverables and Schedule Monthly Progress Reports

Monthly progress reports and Cost Summary Reports shall be submitted to the COR and Contracting Officer. The report shall state separately the total cost for all direct labor and all other charges. The report shall also highlight any problem areas with respect to expenditures relative to budget, progress relative to schedule, and overall resource allocation. In addition to the above stated requirements, the contractor shall promptly inform the COR of any technical, scheduling, or financial issues encountered during performance.

Meeting and Oral Presentations

As a minimum, the Contractor will conduct face-to-face meetings or webinars to discuss project progress for the following:

- Kick-off Meeting
- Verification of functionality of available tank car
- Modification Plan
- Progress of redesign and modification

The Contractor will provide PowerPoint presentation of the meeting discussion topics to guide the meeting. The Contractor will participate in all test planning and related meetings with the FRA. These meeting may include 3rd party contractors supporting the FRA on the overall test program. FRA will inform the Contractor of upcoming meetings at least 10 days in advance of the meeting.

Period of Performance

The total period of performance for both Phases is 24 months.

Milestone Payment Schedule

The contractor shall propose a milestone payment schedule tied to deliverables for each phase in the SOW to facilitate invoicing and payments.

DELIVERABLES & SCHEDULE

PHASE I

1. Kick-off meeting	1 month from award
2. Preliminary Submission of design	2 months from award
3. Revision of design,	3 months from award
4. Approval of design	4 months from award
5. Fabrication	6 months from award
6. Inspection of fabricated fixture	7 months after award
7. Plan for installation of fixture	8 months from award
8. Installation of fixture	10 months from award
9. Draft summary report for	11 months from award

PHASE II

10. Verification of tank car	2 months from award
11. Modification plan	3 months from award
12. Design and schedule for modification	4 months from award
13. Actual modification	6 months from award
14. Support for test	8 months from award
15. Draft Final report	10 months from award
16. Final report & Recommendations	12 months from award